

1 **Claims**

2

3 1. A method of insulating a subsea structure, the
4 method comprising:
5 injecting a substance into the subsea structure;
6 allowing said substance to form a gel, wherein
7 the formed gel has a dynamic viscosity of more
8 than 1000Pa.S.

9

10 2. A method as claimed in claim 1, wherein the
11 formed gel has a dynamic viscosity of over 2000
12 Pa.S.

13

14 3. A method as claimed in either preceding claim,
15 wherein the substance comprises a hydrocarbon.

16

17 4. A method as claimed in any preceding claim,
18 wherein the formed gel retains its integrity
19 unsupported.

20

21 5. A method as claimed in any preceding claim,
22 wherein the substance is a pourable fluid prior to
23 forming the gel.

24

25 6. A method as claimed in any preceding claim,
26 wherein cenospheres or microspheres are added to the
27 substance.

28

29 7. A method as claimed in any preceding claim,
30 wherein spheres enclosing hydrocarbon gas are added
31 to the substance.

32

1 8. A method as claimed in any preceding claim,
2 wherein the substance comprises wax.

3

4 9. A method as claimed in claim 8, wherein the wax
5 is a highly branched chain wax.

6

7 10. A method as claimed in any preceding claim,
8 wherein the subsea structure comprises a conduit,
9 said conduit enclosing a second conduit.

10

11 11. A method as claimed in claim 10, wherein the
12 method comprises recovering hydrocarbons within the
13 second conduit.

14

15 12. A method as claimed in any claim 11, wherein
16 the gel is adapted to transfer a portion of the
17 hydrostatic pressure on the first conduit onto the
18 second conduit.

19

20 13. A method as claimed in any one of claims 10 to
21 12, wherein the thermal properties of the gel is
22 varied over the length of a conduit or series of
23 conduits.

24

25 14. A method as claimed in any preceding claim,
26 wherein the substance comprises a polymeric compound
27 and a transition metal salt.

28

29 15. A method as claimed in claim 14, wherein at
30 least one of the polymeric compound and transition
31 metal salt is encapsulated in wax.

32

1 16. A method as claimed in claim 14 or claim 15,
2 wherein the polymeric compound comprises a
3 phosphate.

4

5 17. A method as claimed in claim 16, wherein the
6 phosphate comprises an orthophosphate.

7

8 18. A method as claimed in claim 17, wherein the
9 orthophosphate comprises an orthophosphate ester.

10

11 19. A method as claimed in claim 18, wherein the
12 orthophosphate ester has the structure according to
13 formula I:

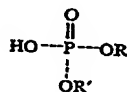
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Formula I

20 wherein R is a straight or branched chain alkyl or
21 alkaryl group having about 6 to about 18 carbon
22 atoms and R' is hydrogen or an aryl, alkaryl or
23 alkyl group having about up to 18 carbon atoms.

24

25 20. A method as claimed in any one of claims 16 to
26 19, wherein about 0.3% to 3.0 wt% of the phosphate
27 is added to the substance.

28

29 21. A method as claimed in any one of claims 15 to
30 20, wherein the transition metal salt and polymeric
31 compound are added in an equimolar ratio.

32

1 22. A method as claimed in any one of claims 14 to
 2 18, wherein the transition metal salt comprises a
 3 ferric salt.

4

5 23. A method as claimed in claim 22, wherein the
 6 ferric salt is selected from the group consisting of
 7 ferric sulphate, ferric citrate, ferric ammonium
 8 sulphate, ferric ammonium citrate, ferric chloride,
 9 and ferric gluconate.

10

11 24. A method as claimed in any one of claims 1 to
 12 13, wherein the substance comprises a first fluid
 13 which has a relatively high specific heat capacity
 14 and a second fluid which has a relatively low
 15 thermal conductivity.

16

17 25. A method as claimed in claim 24, wherein the
 18 first fluid is water and the second fluid is a
 19 hydrophobic fluid, such as oil.

20

21 26. A method as claimed in claims 24 or 25, wherein
 22 the substance comprises a first and a second
 23 polymeric compound, the first polymeric compound
 24 having the general formula

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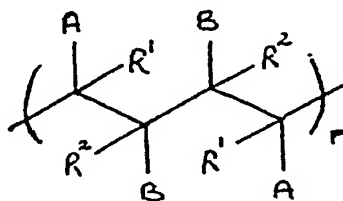
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31 wherein A and B are the same or different wherein at
 32 least one comprises a relatively polar atom or group

1 and R^1 and R^2 independently comprise relatively non-
 2 polar atoms or groups.

3

4 27. A method as claimed in claim 26, wherein R^1 and
 5 R^2 are selected from the group consisting of
 6 hydrogen atoms and alkyl groups.

7

8 28. A method as claimed in any one of claims 26 to
 9 27, wherein A and B are independently selected from
 10 optionally-substituted alkyl, cycloalkyl,
 11 cycloalkenyl, cycloalkynyl, aromatic and
 12 heteroaromatic groups.

13

14 29. A method as claimed in claim 26 to 28, wherein
 15 A represents a phenyl group substituted, preferably
 16 at the 4-position relative to the group C-C, by a
 17 formyl group or a group of general formula:

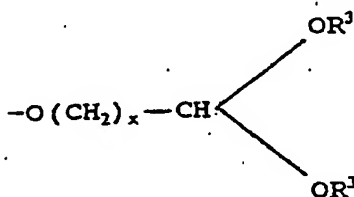
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23 wherein x is an integer from 1 to 6 and each R^3 is
 24 independently an alkyl or phenyl group or together
 25 form an alkalene group.

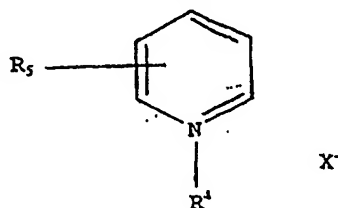
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27 30. A method as claimed in any one of claims 26 to
 28 29, wherein group B represents a group of general
 29 formula:

30

31

32



1 wherein R⁴ represents a hydrogen atom or an alkyl or
2 aralkyl group, R⁵ represents a hydrogen atom or an
3 alkyl group and X⁻ represents a strongly acidic ion.
4

5 31. A method as claimed in any one of claims 26 to
6 30, wherein the second polymeric compound includes a
7 functional group selected from the group consisting
8 of an alcohol, carboxylic acid, carboxylic acid
9 derivative and an amine group.
10

11 32. A method as claimed in any one of claims 26 to
12 31, wherein the second polymeric compound is
13 selected from the group consisting of
14 polyvinylalcohol, optionally substituted
15 polyvinylalcohol, polyvinylacetate, polyalkalene
16 glycols and collagen.
17

18 33. A method as claimed in claim 32, wherein the
19 second polymeric compound is polyvinyl alcohol.
20

21 34. A method as claimed in any one of claims 26 to
22 33, wherein the substance further comprises a
23 catalyst to catalyse the reaction between the first
24 and the second polymeric compounds.
25

26 35. A method as claimed in claim 34, wherein the
27 catalyst is paratoluene sulphuric acid.
28

29 36. A method of insulating a submerged conduit, the
30 method comprising the steps of:

31 applying at least one substance to the conduit
32 before it is submerged; then,

1 submerging the conduit under water; and
2 allowing the substance to form a gel with a
3 dynamic viscosity of more than 1000Pa.S.

4

5 37. A method as claimed in claim 36, wherein the
6 tubular comprises further tubulars enclosed therein.

7

8 38. A method of altering the buoyancy of a subsea
9 structure, the method comprising,

10 injecting a substance into the subsea structure;
11 allowing said substance to form a gel, wherein the
12 formed gel has a dynamic viscosity of more than
13 1000Pa.S.

14

15 39. A method as claimed in claim 38, wherein the
16 substance includes microspheres.